Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently Amended): A mass spectrometer, comprising:

an ion source configured to produce ions from a sample;

an extraction device configured to extract ions from the ion source;

a time-of-flight (TOF) mass analyzer configured to analyze and detect said ions in a normal mass spectrometer mode of operation ~~at least one of a first extraction of ions and ion fragments of said first extraction~~;

an ion trap (IT) mass analyzer configured to analyze and detect said ions in a tandem mass spectrometer mode of operation ~~at least one of a second extraction of the ions and ion fragments of said second extraction~~; and

an ion guiding ~~optical~~ element configured to ~~guide at least one of the~~ direct a first extraction of said ions along a curved trajectory ~~and said ion fragments of said first extraction~~ into the TOF mass analyzer in ~~a~~ the normal mass spectrometer mode of operation, and configured to guide ~~at least one of the~~ a second extraction of said ions ~~and said ion fragments of said second extraction~~ into the IT mass analyzer in ~~a~~ the tandem mass spectrometer mode of operation.

2. (Original): The spectrometer as in Claim 1, wherein the ion source comprises:

an array of samples.

3. (Original): The spectrometer as in Claim 1, wherein the ion source comprises:

a vacuum matrix-assisted laser desorption/ionization (MALDI) source.

4. (Original): The spectrometer as in Claim 1, wherein the ion source is configured to produce ions at normal atmospheric pressure.

5. (Original): The spectrometer as in Claim 4, wherein the ion source comprises:

an electrospray ionization source.

6. (Original): The spectrometer as in Claim 4, wherein the ion source comprises:

an atmospheric pressure MALDI source.

7. (Original): The spectrometer as in Claim 1, wherein the extracting device is configured to time-lag focus extracted ions.

8. (Currently Amended): The spectrometer as in Claim 1, wherein the TOF mass analyzer comprises:

a TOF ion detector configured to detect the first extraction and ~~said~~ ion fragments of said first extraction, and

time-of-flight optics configured to direct the first extraction and said ion fragments of the first extraction to the TOF ion detector and to mass-separate the first extraction and said ion fragments of the first extraction according to a mass-to-charge ratio.

9. (Original): The spectrometer as in Claim 8, wherein the time-of-flight optics comprises:

an acceleration grid configured to accelerate the first extraction and said ion fragments of said first extraction orthogonally to an axis of the extraction device; and

a reflectron configured to reflect accelerated ions towards the TOF ion detector.

10. (Original): The spectrometer as in Claim 8, wherein the time-of-flight optics comprises:

a reflectron.

11. (Original): The spectrometer as in Claim 10, wherein the reflectron is an end-cap reflectron comprising:

a cap of the reflectron; and

a reflecting end electrode electrically isolated from the cap and configured to reflect the first extraction and said ion fragments of said first extraction to the TOF ion detector.

12. (Original): The spectrometer as in Claim 11, wherein the cap is configured with a through-hole to permit said second extraction and said ion fragments of said second extraction to transit through the TOF mass analyzer and enter the IT mass analyzer.

13. (Original):The spectrometer as in Claim 1, wherein the TOF mass analyzer comprises:

a linear TOF mass analyzer.

14. (Currently Amended): The spectrometer as in Claim 13, wherein the linear TOF mass analyzer is configured to transit said first extraction and ~~said~~ ion fragments of said first extraction through said TOF mass analyzer and through said IT mass analyzer and detect transited ions by an IT ion detector.

15. (Currently Amended): The spectrometer as in Claim 1, wherein the IT mass analyzer comprises:

an IT ion detector configured to detect said second extraction and ~~said~~ ion fragments of said second extraction, and

trapping optics configured to trap a portion of said second extraction in a trapping electric field , to isolate and fragment trapped ions, to mass separate the trapped ions according to a mass-to-charge ratio, and to direct trapped ions of a predetermined mass-to-charge ratio to the IT ion detector.

16. (Original): The spectrometer as in Claim 15, wherein the IT mass analyzer comprises:

a quadrupole ion trap mass analyzer, including,

a ring electrode,

an entrance ion trap end cap, and

an exit ion trap end cap,

whereby voltages on the ring electrode, the entrance and exit end caps confine ions in the ion trap and activate or eject confined ions in the ion trap to the ion trap detector.

17. (Original): The spectrometer as in Claim 1, wherein the TOF ion analyzer and the IT ion analyzer utilize a single ion detector.

18. (Currently Amended): The spectrometer as in Claim 1, wherein the ion guiding ~~optical~~ element is configured to establish a first electric field configuration to guide said first extraction and ~~said~~ ion fragments of said first extraction in the TOF mass analyzer in the normal mode of operation and to establish a second electric field configuration to guide said second extraction and ~~said~~ ion fragments of said second extraction to the IT mass analyzer in the tandem mode of operation.

19. (Currently Amended): The spectrometer as in Claim 1, wherein the ion guiding ~~optical~~ element comprises:

at least one optical element of the extraction device, the TOF mass analyzer, and the IT mass analyzer.

20. (Currently Amended): The spectrometer as in Claim 1, wherein the ion guiding ~~optical~~ element comprises at least one multipole ion guide.

21. (Currently Amended): The spectrometer as in Claim 1, further comprising:

a computer configured to control operational voltages on at least one of the ion source, the extraction device, the TOF mass analyzer, and the ion guiding optical element.

22. (Currently Amended): A method of operating a mass spectrometer, comprising the steps of:

producing ions from a sample containing a plurality of atoms or molecules;

extracting the ions from an ion source;

selecting between a time-of-flight mass analyzer and an ion trap mass analyzer;

directing ~~at least one of extracted ions and ion fragments of the extracted ions to said selected mass analyzer based on said selecting step~~ extracted ions along a curved trajectory into the time-of-flight mass analyzer when the time-of-flight mass analyzer is selected and directing the extracted ions to the ion trap mass analyzer when the ion trap mass analyzer is selected; and

~~mass separating directed ions and fragments of the directed ions according to a mass-to-charge ratio;~~

~~detecting mass separated ions with said selected analyzer; and~~

producing ~~at least one of~~ a normal mass spectrum when the time-of-flight mass analyzer is selected and a tandem mass spectrum when the ion trap mass analyzer is selected.

23. (Original): The method as in Claim 22, wherein the step of producing ions comprises:

producing ions from an array of samples to increase sample analysis throughput.

24. (Original): The method as in Claim 22, wherein the step of producing ions comprises:

producing the ions from a vacuum matrix-assisted laser desorption/ionization MALDI source.

25. (Original): The method as in Claim 22, wherein the step of producing ions from a vacuum MALDI source comprises:

providing a laser pulse on the sample to desorb and ionize a portion of the plurality of atoms or molecules from the sample.

26. (Original): The method as in Claim 22, wherein the step of producing ions comprises:

producing ions at normal atmospheric pressure.

27. (Original): The method as in Claim 26, wherein the step of producing ions at normal atmospheric pressure comprises:

producing ions from an electrospray ionization source.

28. (Original): The method as in Claim 26, wherein the step of producing ions from an ion source at normal atmospheric pressure comprises:

producing ions from an atmospheric pressure MALDI source.

29. (Original): The method as in Claim 28, wherein the step of producing ions from an atmospheric pressure MALDI source comprises:

providing a laser pulse on the sample to desorb and ionize a portion of the plurality of atoms or molecules from the sample.

30. (Original): The method as in Claim 22, wherein the step of extracting the ions comprises:

applying a positive voltage to a sample stage to extract positive ions.

31. (Original): The method as in Claim 22, wherein the step of extracting the ions comprises:

applying a negative voltage to a sample stage to extract negative ions.

32. (Original): The method as in Claim 22, wherein the step of extracting the ions comprises:

extracting the ions utilizing a time-lag focusing technique.

33. (Original): The method as in Claim 32, wherein the step of extracting the ions utilizing a time-lag focusing technique comprises:

applying an extraction voltage pulse on a sample stage after a laser pulse desorbs and ionizes a portion of said plurality of atoms or molecules to produce said ions.

34. (Original): The method as in Claim 22, wherein the step of selecting comprises:

applying a first controllable voltage to an ion guiding optical element to direct extracted ions to the time-of-flight mass analyzer.

35. (Currently Amended): The method as in Claim 22, wherein the step of directing comprises:

guiding at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions with at least one optical element of the TOF mass analyzer and the IT mass analyzer.

36. (Currently Amended): The method as in Claim 22, wherein the step of directing comprises:

guiding at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions with multipole ion guides.

37. (Currently Amended): The method as in Claim 22, wherein the step of directing

comprises:

directing at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions by orthogonally accelerating the extracted ions.

38. (Original): The method as in Claim 37, wherein the step of directing by orthogonally accelerating the extracted ions comprises:

accelerating at least one of the extracted ions and said ion fragments of the extracted ions orthogonal to an axis of an extraction device.

39. (Original): The method as in Claim 37, wherein the step of accelerating orthogonal to an axis of the extraction device comprises:

applying periodically potentials between acceleration grids located on an axis with the extraction device.

40. (Currently Amended): The method as in Claim 22, wherein the step of ~~mass-separating~~ producing comprises:

mass-separating the directed ions and ~~said~~ ion fragments of the directed ions with a linear TOF mass analyzer.

41. (Original): The method as in Claim 40, wherein the step of mass-separating with a linear TOF mass analyzer comprises:

guiding at least one of the extracted ions and said ion fragments of the extracted ions through said TOF mass analyzer and through said IT mass analyzer; and

detecting guided ions and fragments of the guided ions by an IT ion detector.

42. (Currently Amended): The method as in Claim 22, wherein the step of ~~mass-separating~~ producing comprises:

mass-separating the directed ions and ~~said~~ ion fragments of the directed ions with a reflectron TOF mass analyzer.

43. (Original): The method as in Claim 42, the step of mass-separating with a reflectron TOF mass analyzer comprises:

applying a reflecting potential to a reflecting electrode of the reflectron TOF mass analyzer;

reflecting at least one of the extracted ions and said fragments of the extracted ions; and

detecting reflected ions and ion fragments of said reflected ions with a TOF ion detector.

44. (Currently Amended): The method as in Claim 22, wherein the step of selecting comprises:

applying a second controllable voltage to an ion guiding ~~optical~~ element to direct ~~the~~ at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions to the ion trap analyzer.

45. (Currently Amended): The method as in Claim 22, wherein the step of ~~mass-separating~~ producing comprises:

trapping said at least one of the extracted ions and ~~said~~ fragments of the extracted ions in an ion trap; and

mass-isolating and mass-fragmenting trapped ions.

46. (Original): The method as in Claim 45, wherein the step of trapping with an ion trap comprises:

scanning a trapping field between an entrance ion trap end cap, an exit ion trap end cap, and a ring electrode of a quadrupole ion trap mass analyzer.

47. (Original): The method as in Claim 45, wherein the step of trapping with an ion trap comprises:

scanning in frequency a radio frequency signal on a ring electrode of a quadrupole ion trap mass analyzer.

48. (Original): The method as in Claim 45, wherein the step of trapping with an ion trap comprises:

scanning in voltage a radio frequency signal on a ring electrode of a quadrupole ion trap mass analyzer.

49. (Currently Amended): The method as in Claim 22, wherein the step of ~~detecting mass-separated ions~~ producing comprises:

utilizing a single ion detector as both an TOF ion detector and an IT ion detector.

50. (Currently Amended): A mass spectrometer, comprising:

means for producing ions from an ion source including a sample containing a plurality of atoms or molecules;

means for extracting the ions from the ion source;

means for selecting between a time-of-flight mass analyzer and an ion trap mass analyzer;

means for directing ~~at least one of extracted ions and ion fragments of the extracted ions~~ extracted ions along a curved trajectory into the time of flight mass analyzer when the time-of-flight mass analyzer is selected, said means for directing configured to direct the extracted ions to the ion trap mass analyzer when the ion trap mass analyzer is selected; and

~~means for mass-separating directed ions and fragments of the directed ions according to a mass-to-charge ratio;~~

~~means for detecting mass-separated ions with said selected analyzer; and~~

means for producing ~~both~~ a normal mass spectrum when the time-of-flight mass analyzer is selected and a tandem mass spectrum when the ion trap mass analyzer is selected.

51. (Original): The spectrometer as in Claim 50, wherein the means for producing ions comprises:

means for producing ions from an array of samples to increase sample analysis throughput.

52. (Original): The spectrometer as in Claim 50, wherein the means for producing ions comprises:

means for producing the ions from a vacuum matrix-assisted laser desorption/ionization (MALDI) source.

53. (Original): The spectrometer as in Claim 50, wherein the means for producing ions from a vacuum MALDI source comprises:

means for desorbing and ionizing a portion of the plurality of atoms or molecules from the sample.

54. (Original): The spectrometer as in Claim 50, wherein the means for producing ions comprises:

means for producing the ions at normal atmospheric pressure.

55. (Original): The spectrometer as in Claim 50, wherein the means for extracting the ions comprises:

means for extracting the ions utilizing a time-lag focusing technique.

56. (Currently Amended): The spectrometer as in Claim 50, wherein the means for selecting comprises:

means for guiding at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions to at least one of the time-of-flight mass analyzer and the ion-trap mass analyzer.

57. (Currently Amended): The method as in Claim 50, wherein the means for directing comprises:

means for guiding at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions with ~~an optical~~ a guiding element from at least one of the TOF mass analyzer and the IT mass analyzer.

58. (Currently Amended): The spectrometer as in Claim 50, wherein the means for directing comprises:

means for guiding at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions with a multipole ion guide.

59. (Currently Amended): The spectrometer as in Claim 50, wherein the means for directing comprises:

means for accelerating orthogonal to an axis of the means for extracting at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions to the TOF mass analyzer.

60. (Currently Amended): The spectrometer as in Claim 50, wherein the means for ~~mass-separating~~ producing comprises:

means for reflecting at least one of the extracted ions and ~~said~~ ion fragments of the extracted ions to the means for detecting.

61. (Currently Amended): The spectrometer as in Claim 50, wherein the means for ~~mass-separating~~ producing comprises:

means for scanning a voltage on said means for mass-separating.

62. (Currently Amended): The spectrometer as in Claim 50, wherein the means for ~~mass-separating~~ producing comprises:

means for scanning in frequency a radio frequency signal on said means for mass-separating.

63. (Currently Amended): The spectrometer as in Claim 50, wherein the means for ~~mass-separating~~ producing comprises:

means for scanning in voltage a radio frequency signal on said means for mass-separating.

64-71 (Canceled).

72. (New): The spectrometer of Claim 1, wherein said ion guiding element is configured to reflect the first extraction in a direction opposite to a direction of the first extraction.

73. (New): The method of Claim 22, wherein the directing comprises:

reflecting the first extraction in a direction opposite to a direction of the first extraction.

74. (New): The spectrometer of Claim 50, wherein said means for directing is configured to reflect the first extraction in a direction opposite to a direction of the first extraction.

75. (New): The spectrometer of Claim 1, wherein said ion guiding element is configured to direct the first extraction at least orthogonally along the curved trajectory.

76. (New): The method of Claim 22, wherein the directing comprises:

reflecting the first extraction at least orthogonally along the curved trajectory.

77. (New): The spectrometer of Claim 50, wherein said means for directing is configured to reflect the first extraction at least orthogonally along the curved trajectory.

78. (New): The spectrometer of Claim 1, wherein said ion guiding element is configured to direct the first extraction about orthogonally along the curved trajectory.

79. (New): The method of Claim 22, wherein the directing comprises:

reflecting the first extraction about orthogonally along the curved trajectory.

80. (New): The spectrometer of Claim 50, wherein said means for directing is configured to reflect the first extraction about orthogonally along the curved trajectory.

81. (New): The spectrometer of Claim 1, wherein the TOF mass spectrometer is configured to produce in said normal mass spectrometer mode of operation a full mass range spectrum of the first extraction, and the IT mass analyzer is configured to produce in said tandem mass spectrometer mode of operation a reduced mass range spectrum of the second extraction, said reduced mass range spectrum reduced in mass range relative to the full mass range spectrum.

82. (New): The method of Claim 22, wherein the producing a normal mass spectrum comprises:

producing a full mass range spectrum of the first extraction; and

producing a reduced mass rage spectrum of the second extraction, said reduced mass range spectrum reduced in mass range relative to the full mass range spectrum.

83. (New): The spectrometer of Claim 50, wherein said means for producing is configured to produce a full mass range spectrum of the first extraction and to produce a

reduced mass rage spectrum of the second extraction, said reduced mass range spectrum reduced in mass range relative to the full mass range spectrum.

84. (New): A mass spectrometer, comprising:

an ion source configured to produce ions from a sample;

an extraction device configured to extract ions from the ion source;

a time-of-flight (TOF) mass analyzer configured to analyze and detect said ions in a normal mass spectrometer mode of operation ;

an ion trap (IT) mass analyzer configured to analyze and detect said ions in a tandem mass spectrometer mode of operation; and

an ion guiding element disposed in front of both the TOF mass analyzer and the IT mass analyzer, said ion guiding element configured to guide a first extraction of said ions into the TOF mass analyzer in the normal mass spectrometer mode of operation, and configured to guide a second extraction of said ions into the IT mass analyzer in the tandem mass spectrometer mode of operation.